# Creating Renewable Energy From Livestock Waste: Overcoming Barriers to Adoption

WIndiana/Indiana Renewable Energy Conference
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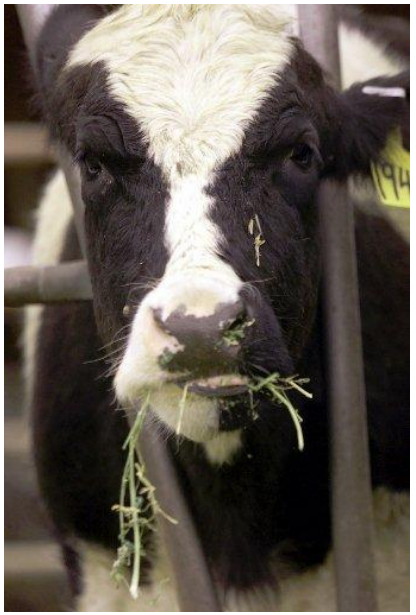
# Agenda and Goals for Today

- The opportunity for livestock waste
- Barriers to adoption
- Conclusion

# Opportunity for Livestock Operations

- Livestock operations have considerable energy generating potential
  - Biomass is low-cost
  - Collected in one spot
  - Consistently supplied
  - Proven technology to harvest the energy
  - Economics can be greatly enhanced by processing other organic materials



# Manure Trivia

How much manure does a lactating dairy cow produce daily?

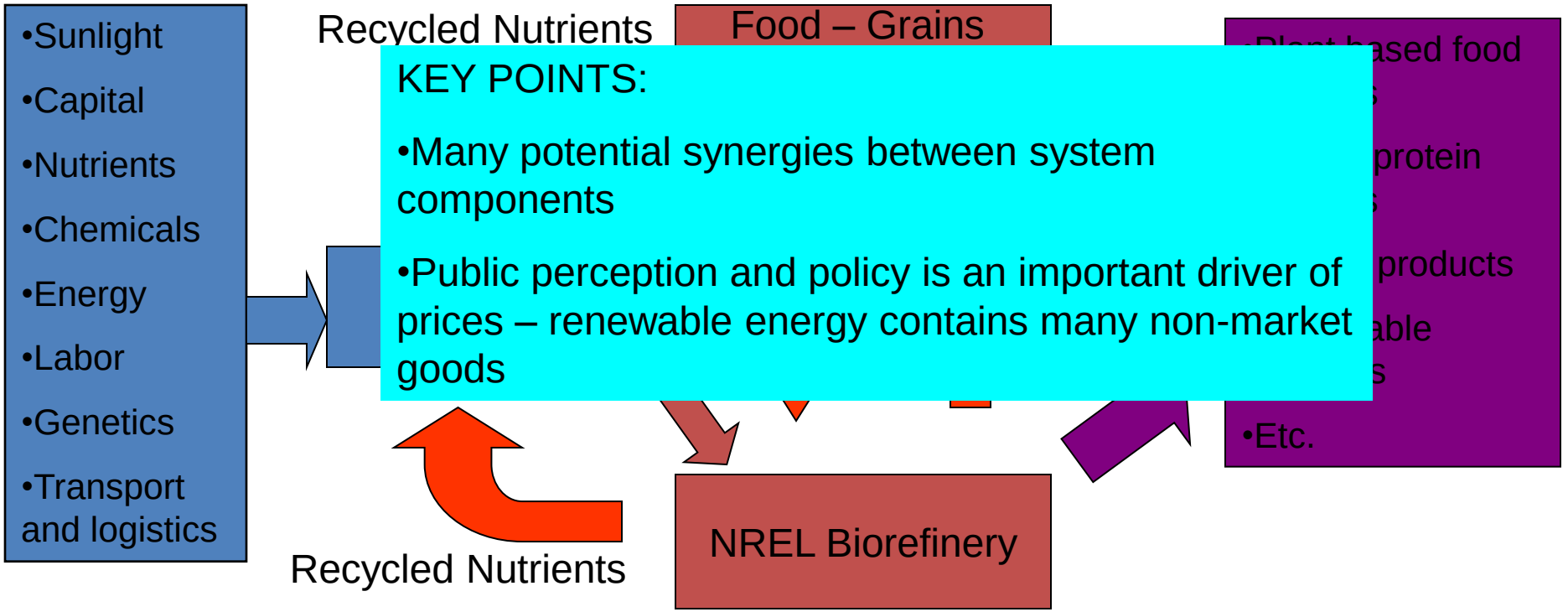
A) 50 lbs
B) 100 lbs
C) 150 lbs
D) 200 lbs
E) More than 200 lbs

# Livestock Sector

- Economics drives towards CAFO's
  - Large farms = large piles
  - Increasing pressure to treat
  - Increasing regulation
  - Waste is one limiting factor in drive to larger systems


849
485
483

# Understanding the Agricultural System



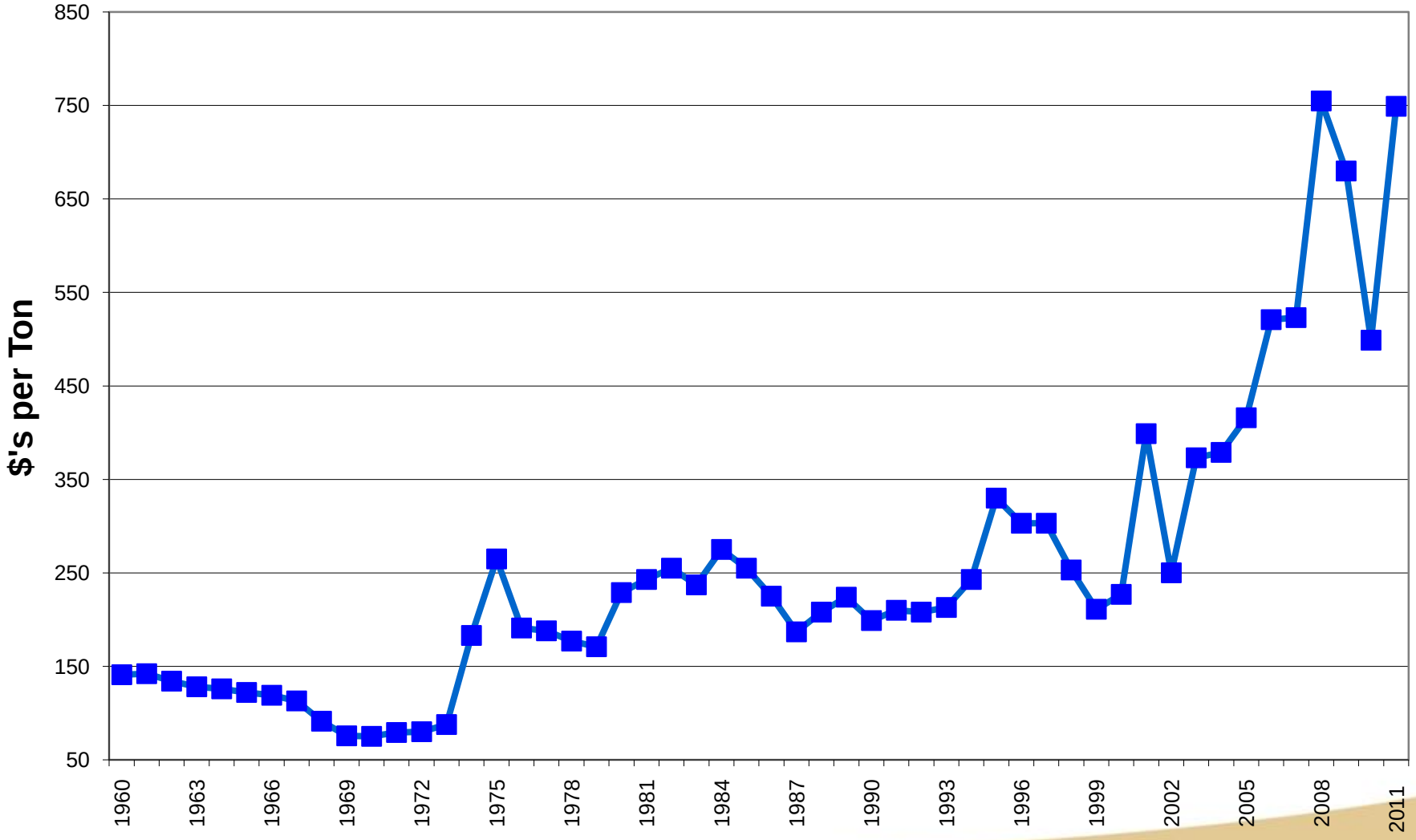

**Optimal output of the system determined by:**

- Relative prices for each input/output
- Costs/technology for conversion of inputs to outputs

# Consider Manure

- On most farms manure is currently treated as a waste with a negative economic value
- This may soon change
  - Rising energy prices
  - Rising fertilizer prices
  - Improved technology for nutrient and energy recovery
  - Increasing scale of livestock operations
  - Increasing negative public attitudes toward livestock wastes – air quality and nutrient capture

# Anhydrous Ammonia Prices 1960-2011






Source: ERS, USDA

# Anaerobic Digestion

- Works with wet material
- Well known and understood
- Biogas = 55-65% methane + impurities
- Various styles and approaches to technology

# Anaerobic Digestion of Livestock Waste

- Breakdown of organic material in an oxygen free environment (air tight tank)
- Designed to handle high moisture products
- Methanogenic bacteria process organic materials to produce biogas (60-70% methane)
- Gas can be cleaned to be equivalent to natural gas
- Reduces odors in livestock waste
- Simple process creates a compost type fertilizer product

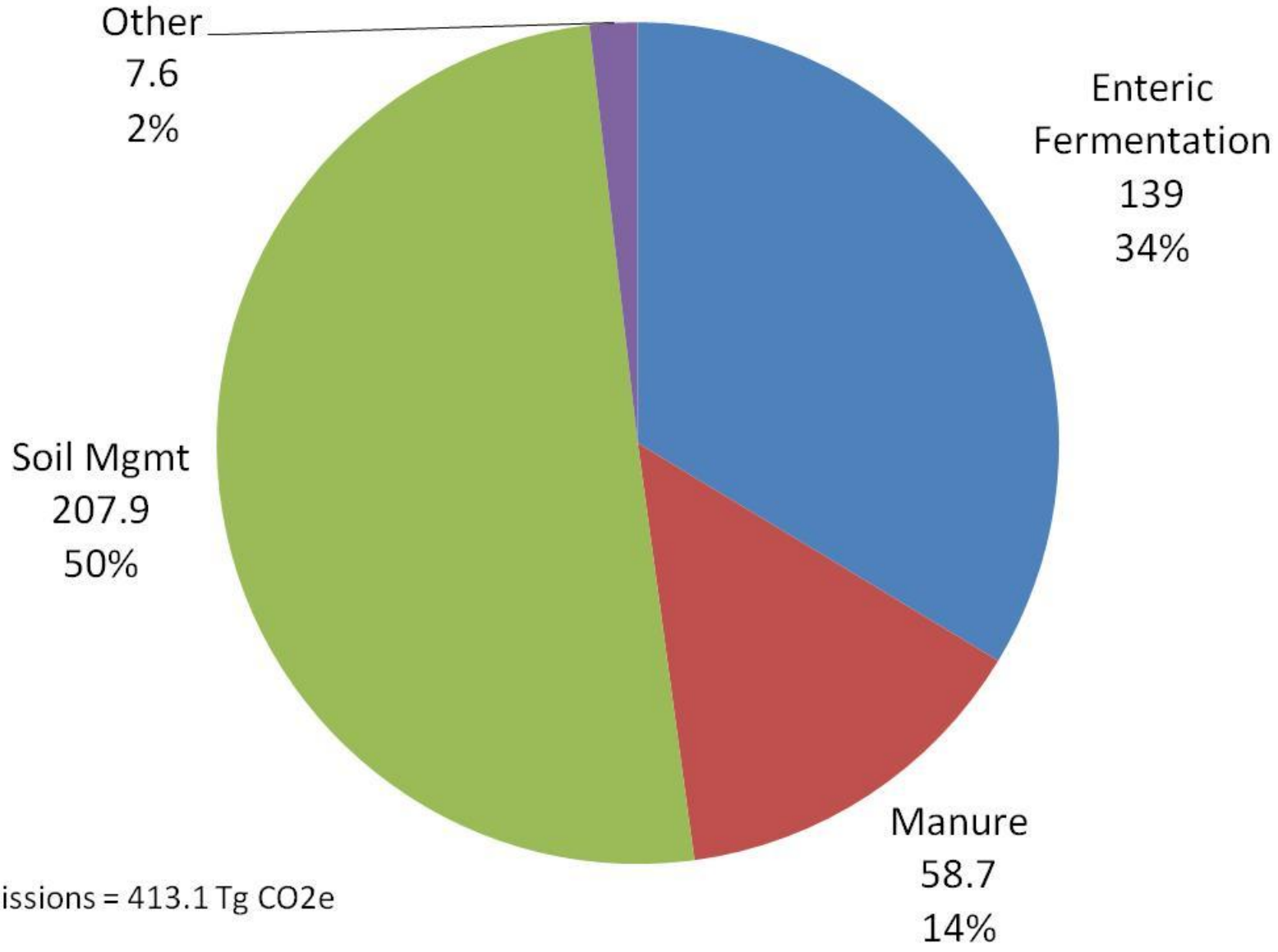
# Anaerobic Digester

# The Products of AD

- Renewable energy
  - Typically electricity
- Waste management
  - Odor control and intensive waste management
- GHG reduction
  - Methane gas destruction

Given the limited adoption of AD in the U.S. it is obvious that at current prices for these outputs, the incentives are insufficient for adoption.

# Agricultural CO2e Emissions by Source, 2007

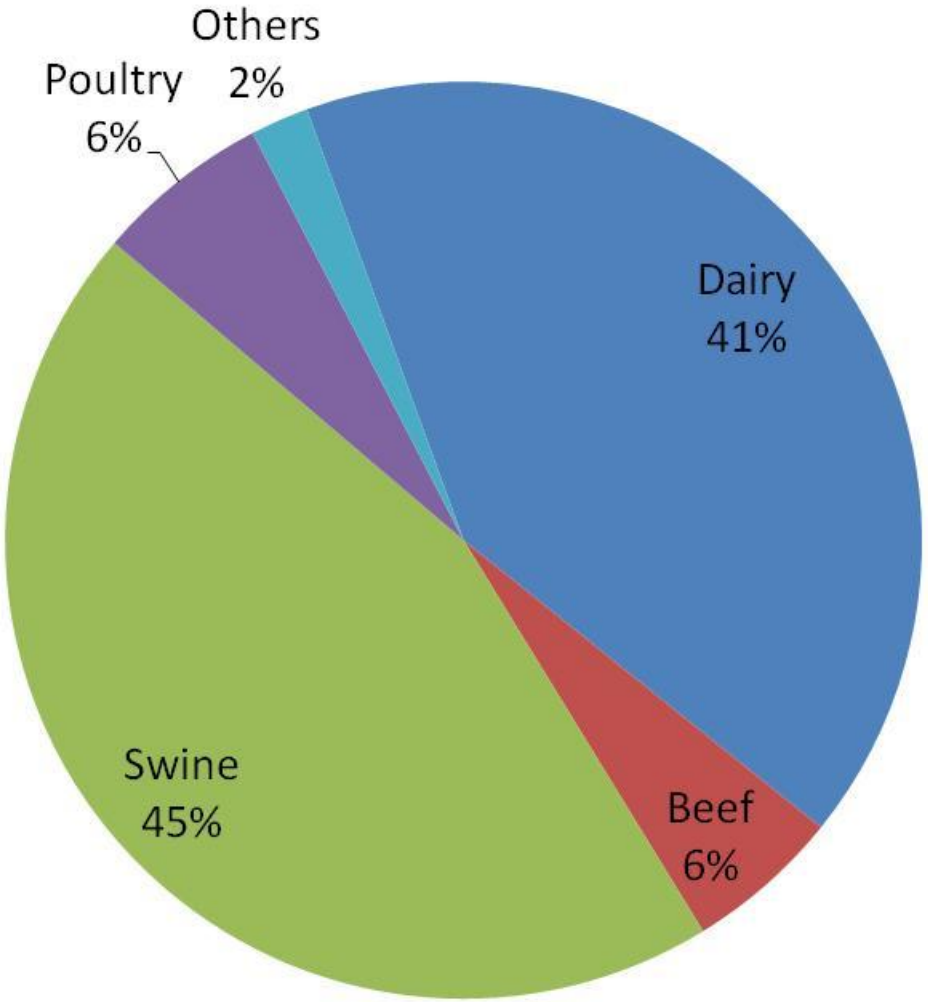



Source: Inventory of U.S. Greenhouse Gas Emissions and Sinks: 1990-2007, April 15, 2009. U.S. EPA.

# Percent of Manure Methane Emissions by Livestock Sector, 2007

Manure methane is frequently viewed as an important potential ag offset.

Offset created by capturing and combusting the methane (gwp = 21 vs. CO2 =1)




Total Methane Emissions = 44 Tg CO2e

Source: Inventory of U.S. Greenhouse gas Emissions and Sinks: 1990-2007, April 15, 2009. U.S. EPA.

# Room for More AD in the US?

- Digesters: 97 operating and 80 in planning in the US (2006 AgStar)
  - Germany today operates 1,900+ farm biogas plants
- Potential sites: 6,904 dairies and hog sites that are legitimate candidates (EPA)
  - Would result in a 66% methane reduction for these sectors
- For dairy alone manure methane emissions in dairy could be reduced by 50% with a carbon price of $15 per MT CO2e

# What We Know About AD

- Currently few biogas applications with very positive economic situations
- Traditional biogas systems have not fared well
- Technology is improving
- Energy prices are rising
- Economics of each project are highly dependent upon the situation

# Keys to Economical Biogas Systems

1. Scale appropriate for
   - Professional management
   - Modern technology
   - Competitive energy sale
2. Attractive energy sale option
   - Electricity or other use for gas
   - Willing (enthusiastic) buyer
   - Able to monetize environmental attributes
3. Ability to add wastes beyond manure

# Barriers to Widespread Development

# Barriers to Overcome

1. Site specific approach and technology
   - Manure has low energy density
   - Good for co-digestion
   - Limits number of economical sites
   - Many potential contaminants
   - Large number of farmers to work with
2. Different energy markets
3. Markets for positive externalities

# Low Energy Density of Feedstock

Table 2. Energy Content and Value of Potential AD Feedstocks[a]

| Component | Value |
|---|---|
| Pounds of manure per ton | 2,000 |
| Volatile solids content (%) | 11% |
| Solid conversion to biogas (%) | 30% |
| Cubic feet of biogas per lb of volatile solid converted | 20 |
| BTU's per cubic foot of biogas | 625 |
| BTU's per ton | 850,000 |
| Value per MMBTU ($'s) | 7 |
| Value per ton of waste ($'s/ton) | 5.95 |

[a] Values derived from various sources including: Krich, et.al., Martin and Roos.

# Energy Markets

| Market | Current Status | Potential |
|---|---|---|
| On-farm use | Well established in practice | Limited to energy used by individual farms. |
| Industrial process | Biogas substituted for natural gas by nearby industrial user. Few applications currently in practice. | Very limited/site specific. |
| Electrical | Sold to electrical grid. Commonly used in practice. | Large potential market. Each sale must be negotiated individually. |
| Natural gas transmission network | Biogas must be cleaned and compressed. Only a few applications in the United States. | Large potential market. Standards for biogas quality required are not well developed. Must negotiate with each utility. |
| Transport fuel | Biogas must be cleaned and compressed. Some use in Europe | Large potential market. Many technical and practical hurdles to adoption. |

# Environmental Attributes

- The size and outlook of the opportunity is dependent upon the extent to which consumers and the government remain willing to support the environmental benefits of biogas
  - Produces renewable energy
  - Environmental solutions

# Approaches to Barriers

- Currently there are limited incentives with a mix of local, state, and, federal policies
  - Construction subsidies – high cost (impact ?)
  - Loan guarantees – lower cost and high impact
  - Various state and local policies on net metering
  - Some utilities providing variable rate incentives
  - Voluntary market for environmental attributes

# The Need

- Coherent policy
  - Variable rate incentives for electricity or gas
  - Mandate for renewable electricity – must allow flexibility
  - Clear environmental policy
  - National standards for biogas quality
  - Incentives for new technology development
  - Incentives for new markets (compressed biomethane)
  - Need for industry organization/representation
  - Research on prospects for using other substrates/crops

# Questions

# Supply of CO2 Offsets from Anaerobic Digestion on U.S. Dairy Farms, Million Metric Tons of C02e